2150 Special Planning Areas December 16, 1971
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West Slope of the Tetons Study
(Ecology Report)

James R. Morris, Study Leader

Targhee National Forest

Enclosed are three copies of the Ecology input to the West Slope Tetons Study. One or two additional copies can be provided if you need them. You will note that individual site writeup sheets are included in the appendix of only one copy. I do not consider these to be necessary in the primary report but feel that one copy of this basic data might be useful to you.

You will note that the present copies are not illustrated although space has been left in the typing format so that photos can be added. Illustrative color photographs are on hand for several of the co munity types, for the mahogany appendix document, and for most of the individual writeup sheets. If the study can finance reproduction costs, illustrative photographs can be provided for all copies of the report. Please let me know which, if any, of the photos you would like and I will order them.(

In the interest of time, my report is being submitted in its present form. However, you will note that it could benefit from some heavy editing. Some sections are excessively verbose and some repetition still occurs. If you should conclude that this paper merits wider distribution in furthering the purposes of the study, then I urge that the edit job be done and the manuscript be retyped prior to additional distribution.(

In spite of some frustrations, I enjoyed being a participating member of your study team. I hope you find the enclosed paper a meaningful contribution to the study objective.

L. E. HORTON
Study Team Member

# VEGETATION AND ECOLOGICAL RELATIONSHIPS

West Slope of the Tetons Study Area

Targhee National Forest

By

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Intermountain Region - Forest Service

November 1971

C O N T E N T S

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PREFACE

This paper was prepared as a contribution to the West Slope of the Teton Comprehensive Land Use Study. It is based on field reconnaissance and data collection in 1970 and 1971, literature review, and a review of some file material already on hand. Since time available for study was minimal, the findings should be recognized as both generalized and preliminary. Portions of parts IV and V are left incomplete because of insufficient time to complete their development. A number of appendix documents could be added at a later time if it seems desirable to do so.

The paper attempts both to characterize the vegetation of the study area and to interpret ecological interactions and responses. Because it is so generalized, it probably raises more questions than answers. However, it, hopefully, identifies some of the possible interactions significant to management decisions and can serve to focus attention on biological matters appropriate for further study.

## PART I - GENERAL DESCRIPTION OF THE STUDY AREA AND ITS VEGETATION

### General Description

The West Slope of the Tetons Study Area contains about 375,000 acres in Teton County, Wyoming and Teton and Fremont Counties, Idaho. It is bordered on the east by Grand Teton National Park and on the north by Yellowstone National Park. The floristics of both National Parks and of Teton County, Wyoming, have been previously studied in some detail by various authors (Reed, 1952; Shaw, 1958; Beetle, 1961; McDougall and Baggley, 1956). However, the present study area is more or less geographically isolated from those areas and was not well represented in the earlier taxonomic work.

Topographically, the study area can be segmented into two parts along a line extending from about where Leigh Creek leaves the Forest to the north side of Hominy and Survey Peaks. The northwest part is a plateau-like region of low relief with elevations ranging from 5,900 to 7,250 feet above sea level. The southeastern portion is a mountainous area of high relief and consists of the west flank of the Teton Range. Elevations in this area range from 6,400 at the western boundary to over 11,000 feet at the peaks along the eastern boundary.

The study area has had an active geologic past. Extensive faulting and folding occurred in the formation of the Teton Range, including the mountainous portion of the study area. Extrusive flows of rhyolite and andesite extended over much of the area during Tertiary times.

Three periods of glaciation during the Pleistocene strongly influenced the present-day landscape. Loessal depositions are significant in the western part of the plateau region. Much of the mountainous area consists of westward dipping sedimentary beds deeply incised by canyon troughs from east to west. Pre-Cambrian "granitics" are exposed in some of the upper basins and deeply cut canyons. Many present-day features are those typical of mountain glaciation. The plateau region is generally underlain by the extrusive volcanics, partially scoured by glacial action and partially capped with glacial drift.

Climate of the study area has been described as cool temperate. However, no weather stations occur on the area itself and nearby stations are all in valley locations. Therefore, most climatic data for the study area is available only by extrapolation. The eastern part of the plateau area (7000-foot elevation) is climatically equivalent to near a 9000-foot elevation of the mountain area, judging by the character of the vegetation and some limited climatic data. Apparently, this is due to a topographic influence on air mass movements.

Mean monthly temperature (Appendix 3 ) near the western boundary of the study area reaches a maximum of 60+° F in July and is below freezing from November through March. Based on reported data from stations at various elevations, Meier (Nelson et al, 1968) has calculated temperature lapse rates for the plateau area of about 2° F/1000 feet during the winter months, but as high as 6° F in July. Whether these lapse rates would also apply to the mountain area is speculative but certainly some temperature/elevation gradient occurs.

Annual precipitation (Appendix 3 ) at the western boundary is less than 20 inches and exceeds 50 inches at higher elevations. About two-thirds of the precipitation occurs as snow at the lower elevations, the proportion tending to increase with elevation. May and June are typically months of plentiful precipitation and storms occur throughout the summer. Periods of severe drought are infrequent.

Soil moisture is normally ample during the main growing period and herbage growth reaches its peak in late July. Temperature appears to be a greater controlling influence on plant growth than does precipitation. Prevailing winds are westerly both summer and winter throughout the study area.

## Physiognomy

The study area is generally forested except at higher elevations where the forest becomes patchy and a park-like appearance predominates. Vegetation life zones progress on a general elevation-exposure gradient from the lower Montane Zone through the Subalpine Zone. Minor amounts of the Alpine Zone occur at the highest elevations. Prior to settlement of Teton Basin, there apparently was a substantial belt of aspen occupying a zone between semi-desert sagebrushgrass and Douglas-fir montane. The eastern edge of the zone approximated the present National Forest boundary. Much of the aspen type was converted to farmland during settlement but some remnants still occur as extentions into the study area.

A number of nonforested azonal and/or local situations occur throughout the area. Many of the nonforested sites at lower elevations are seral stages of burn succession or are the product of local geophysical anomalies. Although often of minor areal extent, many of these local community types may be very significant in terms of ecological interactions and are important in creating biological diversity. A total of 29 existing plant community types have been tentatively identified, several of which are clearly seral successional stages.

Understory vegetation tends in general toward shrubby species in the Montane Zone and toward forbs in the subalpine. Grass species are generally of minor importance to the plant composition with the exception of the pinegrass community complex. In the plateau portion of the study area, the forest overstory tends to be dominated by lodgepole pine, usually in the role of a seral opportunist. The mountainous portion of the study area tends toward Douglas-fir overstory in the Montane Zone and Subalpine fir in the Subalpine Zone.

The area has a high taxonomic diversity, particularly in forb and shrub species, but shows a relative paucity of grasses. The post-glacial vegetation has developed primarily through colonization by migration of the forb-rich Wasatch Mountain flora but shows substantial influx of species of Northern Rocky Mountain flora. Because development of the flora is comparatively youthful, some expected species are conspicuous by their absence. Much of the area gives an impression of luxuriance due to the abundance of mesic shrub and tall forb species. Energy fixation and annual production of vegetation biomass are fairly high, particularly in the Montane Zone of the mountainous area.

## Influences on Community Structure and Development

Recent geologic history of vulcanism, tectonics, glaciation, and loessal deposition with its associated climatic variations, indicates that modern plant associations have occupied their present area for only a few thousand years and post-glacial migrations are not yet fully completed. In fact, it is strongly felt by some that climates are not yet stabilized after the great disturbances of the ice age and that further shifts can be expected. Primary development of the vegetation has been further modified by the influence of wildfire and a change in kind of dominant ungulates.

### Grazing

Historical evidence suggests that the primary macroconsumers (large herbivores) with which the natural plant communities developed consisted of abundant populations of bighorn sheep and bison, lesser numbers of elk and antelope, and some deer. Populations of these animals were apparently decimated by about 1850. They were replaced in the late 1800's by the introduction of domestic sheep and cattle. The effects of this change on the understory flora are locally apparent and probably have had an even broader influence. In recent years, horses have become an important influence in many of the high basin areas.

### Timber Harvest

Recent salvage harvest of beetle-infested lodgepole pine stands has resulted in some sizeable clear-cuts on parts of the plateau area. In terms of plant community structure, this is a catastrophic modification although the total acreage involved is rather small.

The effects of historical timber harvesting are more widespread. Quantitative data are not readily available but it seems probable that the accumulated volumes and number of stems removed were very great. Species and size selectivity further increased the effect of this activity on community structure. Its greatest influence probably relates to the early-day harvest of ties, posts, poles, firewood, etc. Information on the activity has proven elusive and more investigation is needed.

It is interesting to note that the vast majority of trees in the study area are less than 100 years old. Available records of wildfire and insect depredations do not explain the totality of the turn-over although they have evidently played a big role in it. I suspect that historical timber harvesting has been a much more significant influence than is generally realized.

Wildfire

Current and historical evidence suggests that wildfire has been a very important influence in the creation of existing vegetation patterns. To date, I have found few places in the study area where a diligent search will not reveal some physical evidence of past fire. The relationship of overstory patterns to wildfire is obvious in many cases. Historical evidence gives inference to a 40 to 60 year cycle of major wildfire event referenced as far back as about 1770. Most of the existing lodgepole pine and brushfield communities can be related to this phenomenom. Wildfire appears to be the single most significant influence on the structure and composition of existing plant community types in the study area. It is responsible for much of the overstory

diversity in the mountainous area and for a relative uniformity in the plateau area. The differing effects in the two parts of the study area are presumed to result from topo-meteorological influence but this needs further investigation.

Natural Erosion

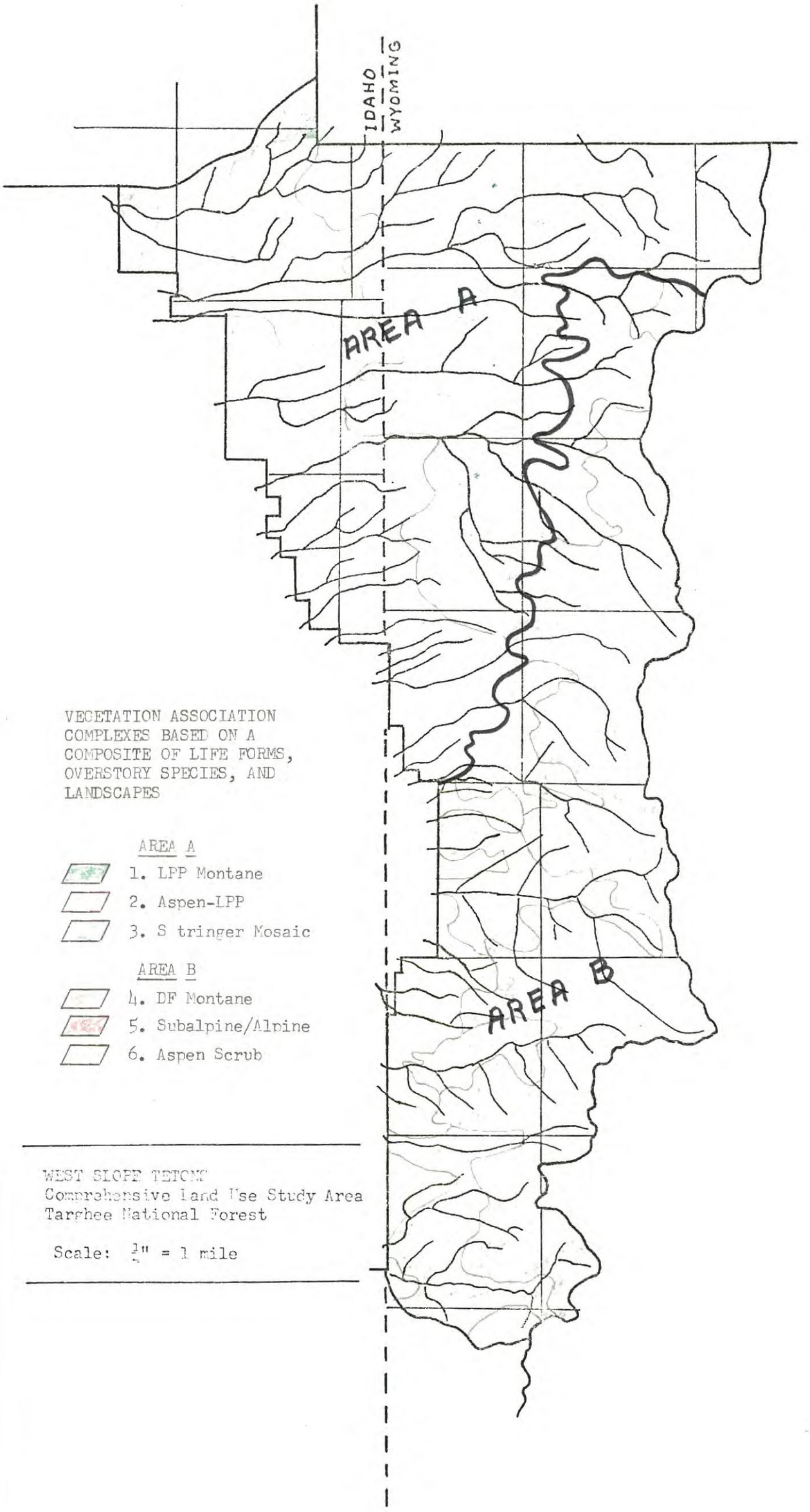
Because the area is relatively youthful, the processes of natural erosion are active in the mountainous portion of the study area. This is reflected in continued degradation and mass wasting on some sites and the deposition of material on others. These natural events can leave long-persistent and visible changes in vegetation and account, in part, for several of the minor plant community types that have been recognized.

## PART II - STRATIFICATION OF VEGETATION ASSOCIATION COMPLEXES

On the basis of existing vegetation life forms, overstory species, climatic influences, and landscape physiography, the study area has been divided into two subareas (Area A and Area B), each of which has, in turn, been subdivided into three vegetation association complexes (see attached map). These complexes are not hierarchically related to plant community types although I would expect that such a relationship might be developed.

The two main vegetation subareas of the study area correlate reasonably well with the divisions described in the "Soil Resource Inventory" report as the southern edge of the Pitchstone Plateau (Area A) and the west flank of the Teton Mountain Range (Area B). The smaller subdivisions (vegetation association complexes) also coincide in a general way with Land Type Group delineation.

The lack of a more clear correlation between vegetation complexes and land type groups in the study area can be attributed to the influence of local climatic diversity and to the very important role of wildfire in the development of existing vegetation patterns. To a lesser extent, man has played the role of an external force in modifying many plant communities. These influences have variously affected the dominants, subdominants, and understorys and have restructured many communities. In addition, some differences are undoubtedly due to a lack of definitive information on which to base the stratification.


IDAHO
WYOMING
AREA A
AREA B
VEGETATION ASSOCIATION COMPLEXES BASED ON A COMPOSITE OF LIFE FORMS, OVERSTORY SPECIES, AND LANDSCAPES
AREA A
1. LPP Montane
2. Aspen-LPP
3. S tringer Mosaic
AREA B
4. DF Montane
5. Subalpine/Alpine
6. Aspen Scrub
WEST SLOPE TETONS
Comprehensive Land Use Study Area
Targhee National Forest
Scale: 1/2" = 1 mile

| Vegetation Subareas | | Land Type Groups |
|---|---|---|
| Area A | | |
| 1. LPP Montane | _____ | F. Rhyolite Uplands |
| 2. Aspen-LPP | _____ | E. Glacial Driftlands |
| 3. Stringer Mosaic | _____ | D. Rhyolite Tablelands |
| Area B | | |
| 4. DF Montane | _____ | B. Dissected Midlands |
| 5. Subalpine/alpine | _____ | A. Glaciated Ridgelands |
| 6. Aspen Scrub | _____ | C. Colluvial Frontlands |

Unmapped Land Type Group X (Valleylands) is represented in the vegetation by several plant community types such as bottomland sagebrush, aspen scrub, and the Douglas-fir complex.

## Area A (PLATEAU)

Area A is characterized by relatively gentle topography and a dominance of lodgepole pine in the overstory. The area is a general extension of the Pitchstone Plateau of Yellowstone Park which merges into the main Teton Range. It was first subjected to volcanic flows originating to the northeast. Later, glaciation from the southeast left its mark with some scouring, planing, and basin scooping and through deposition of till. Lastly, it was influenced by major loessal depositions from the west and canyon fill of Pinedale glacial drift.

The area flanks the lower portion of the west slope of the Teton Range Along the Forest boundary from about Darby Canyon northward to North Leigh Creek. It then widens to the eastward and includes most

of the northern part of the study area. Buffalo and Bull Lake glaciation have overridden the volcanics with morainal drift in Teton and Leigh Canyons and intermittently over most of the northwest part of the area. This, in turn, has been capped by loess deposition along the Forest boundary from Badger Creek northward. Loess peters out rather quickly as one proceeds easterly from the Forest boundary. Part of the north end has also been scoured by glaciation, leaving a lake-depression terrain with several lakes and wet meadows. Because of the heterogenity described, this area lends itself to further subdivision.

The three tentative subdivisions mapped are based on apparent general differences but available information does not permit a separate treatment of them at this time except for a very general description.

Vegetation for the area as a whole is dominated by lodgepole pine and Douglas-fir forest in various stages of seral succession. Some stands should be recognized as a pyric climax. Occasional wet meadows and willow bottom lands occur throughout the area. A few residual stands of Douglas-fir can be found and subalpine fir occurs in the northeastern part. The northwestern portion of the area supports considerable amounts of aspen intermixed with lodgepole pine. Big sagebrush occupies some of the valley bottoms at lower elevations along the southwestern border of the area. Existing overstory vegetation in Area A is primarily a result of historic wildfire patterns. The area in general is moderately productive of shrub and herbaceous vegetation.

1. Lodgepole Pine Montane

This unit is a composite of several apparently differing situations but available information does not justify a further graphic subdivision at this time. Most of the unit supports seral stands of lodgepole pine of varying size, age, and density which, at times, is mixed with Douglas-fir and/or subalpine fir. The relationship between various lodgepole pine undersotries is not yet defined but most of the typical understory communities appear to be represented in the unit. Some of the stands are clearly temporary and will be succeeded by Douglas-fir or subalpine fir in the next overstory generation. Other stands appear to be a pyric climax of lodgepole pine overstory. That is, they have been held in a seral state for a very long time by cylic wildfire event and have now so modified the microcharacteristics of their site that lodgepole pine will continue to succeed itself indefinitely into the future. A small area in the higher elevation eastern part contains representation of beargrass understory community--(the only occurrence of this community found in the study area).

The unit also contains representation of several other plant community types, the more common being willow, wet meadow, riparian, aquatic, and some remnants of the Douglas-fir complex.

2. Aspen/Lodgepole Pine

This unit was separated primarily because of the abundance of aspen as a competitor to lodgepole pine in the overstory. Further study is needed to identify the reason for the observable differences. It probably represents an ecotone between the aspen zone (now mostly cleared for agriculture) and the montane wherein historic wildfire

has pitted aspen against lodgepole pine as seral opportunists. Understory communities appear similar to those of the present lodgepole pole montane unit, suggesting that the potential natural climaxes are similar. Present differences probably reflect differing developmental histories.

The unit also contains scattered wet meadow, riparian, and aquatic communities associated with the lakes and glacial depressions.

3. Stringer Mosaic

This unit was separated on the basis of an observable difference in the pattern or arrangement of community types--not because of differences in the types themselves.

The unit is basically a tableland formed of rhyolite flows and repetitively dissected in an east-west direction by narrow stream valleys. The intervalley tablelands are occupied, for the most part, with lodgepole pine stands that appear quite similar to those found elsewhere throughout the plateau region. Valley bottoms are commonly occupied by the bottom land sagebrush community type with aspen on the south exposure slope breaks and stringers of the Douglas-fir complex on steeper north exposures.

## Area B (MOUNTAIN)

Area B is characterized by rugged topography and a highly diverse mosaic of vegetation types. It is an area of westward dipping sedimentary rocks with a series of massive limestone and dolomite strata forming the structural control of the landscape. Extensive faulting

and folding has occurred throughout the area and bedrock displacement is commonplace. The area is incised by several deeply entrenched canyons. Glaciation was the major earth-shaping force at higher elevations. Many of the canyons are deeply scoured by valley glaciers and some of them are well filled with glacial and alluvial outwash. The dominant feature is the structural control exerted by the sedimentary beds.

The area includes a typical, though discontinous, range of vegetation life zones extending from aspen scrub on the low elevation westerly exposed scarplands, through the Douglas-fir Montane and Subalpine Zones, and includes small areas of the Alpine Zone at high elevations. Because of the extreme variations in slope and exposure throughout the area, zonal patterns of vegetation are frequently interrupted. The plant community diversity is further increased by the frequent occurrence of localized wildfire successional patterns.

Stands of Douglas-fir with mixed shrub understory predominate in the Montane Zone but they are frequently interrupted with tall forb openings, seral brushfields, and lodgepole pine stands. The Subalpine Zone is largely of subalpine fir overstory with extensive tall forb interspaces. A number of azonal plant communities occur throughout the area.

Extensive areas of barren exposed bedrock are common at higher elevations and often intergrade with alpine vegetation. Massive cliff walls are typical of many of the canyons. Most of the area is highly productive of shrub and herbaceous vegetation wherever soil depth to bedrock is adequate.

4. Douglas-fir Montane

The unit includes much of the Moose Creek, Game Creek, Fox Creek, Darby Creek, Teton Creek, and Leigh Creek drainages as well as some localized sites as far north as Hominy Peak. The boundary between the Montane and Subalpine Zones is represented by a broad and often poorly defined ecotone. Irregularities in slope and exposure often result in plant communities occurring well above or below their normal elevational range.

Present patterns of tree species distribution suggests that overstory vegetation has been altered from the climax dominance in several places, probably relating to recent and historic fire events. Also, present understory composition appears to have been modified in some places, probably as a result of faulty management of domestic livestock. Tall forb communities have frequently been altered by reduction in taxonomic diversity and tendency toward single or few species dominance. These changes can probably be attributed to improperly managed sheep grazing.

The dominant potential natural vegetation of the bulk of this area is Douglas-fir/tall huckleberry and Douglas-fir/mixed shrub types grading into spruce-subalpine fir at the higher elevations. Isolated cold pockets of Engelmann spruce also occur as discontinuities throughout the area, particularly along streams and in moist coves. The understory is characterized, in general, by a luxuriant appearance and high taxonomic diversity. Dominant species vary from site to site but species occurrence was observed to be quite similar regardless of site. Incidental openings support tall forb communities. Aspen frequently occupies the unstable south exposure colluvial slopes

between major ledges of sedimentary outcrop. In some cases, curlleaf mahogany occupies these positions. Depositional bottom lands are occupied variously by wet meadow, sagebrush, and willow depending upon soil mantle drainage and regressional stages. Inclusive pockets and patches of lodgepole pine and brushfield types occur through the area, apparently--in some cases obviously--associated with burn succession, but tending to be more common at lower elevations. Upland sagebrush communities occupy some ridges and south exposure slopes at middle elevations.

5. Subalpine/Alpine

This unit is a complex that includes all of the high elevation country in the study area. Precambrian granitics and metamorphosed rocks are exposed in many of the high basins and deeply cut valleys. The upper extensions of massive west-dipping limestone and dolomite beds underlay the rest of the unit. Upper basins and headwaters have been heavily glaciated.

Since the unit includes both Subalpine and Alpine Zones the vegetation is a heterogeneous array of plant community types of which spruce-subalpine fir forest and tall forb park land are the most prevalent. Other types represented include seral upland lodgepole pine, whitebark-limber pine, alpine meadows, alpine tundra, and alpine and subalpine barrens. The latter types consist of fairly extensive areas of exposed and near barren bedrock. Another ill-defined type is formed by the near vertical cliff walls common to the area.

Depth of soil development over bedrock and a rigorous high elevation climate are the dominant influences on vegetation life form and community structure and composition. Past livestock grazing has modified many of the plant communities in the area, particularly the tall forb and meadow types.

6. Aspen Scrub

Low-elevation west-facing exposures along the Cache Creek fault-line scarp support a scrubby aspen growth intermixed with shrub and seral lodgepole pine types. The unit coincides closely with Land Type Group C (Colluvial Frontlands) reported in the Soil Resource Inventory Report. It is located along the west Forest boundary from about Leigh Creek southward. There is little stream dissection in the unit and mass-wasting across the truncated bedrock strata is thought to be the dominant landforming process currently active. The presence of aspen scrub is thought to reflect the subsurface instability of the colluvial slopes.

Most of the unit supports stands of low quality aspen with a mixed shrub understory. Forbs and grasses are fairly well represented in the understory and openings support a forb-grass cover. In general, the unit is moderately to highly productive of herbaceous vegetation.

## PART III - PLANT COMMUNITY TYPE DESCRIPTIONS

Each individual species has its own environmental amplitude. That is, there is a range of values that it can tolerate for each property of the environment important to plant welfare. The species is competitively viable within only a portion of that range--its optimum. Some species have a wide range of tolerance; others have a narrow range. Sometimes, there is a wide range for some properties and narrow for others for an individual species. These differences are the basis for the great complexity in vegetation. Changes in value of one or more of the environmental properties on a site is the basis for plant succession and regression. Within the array of tolerance limits among species, there is a tendency for clustering of optimum values for several species resulting in plant aggregations called communities.

Overstory and understory layers tend to occupy their areas more or less independently, responding more directly to abiotic than to biotic influences. Climax overstories usually relate more closely to macroclimatic characteristics whereas understories are more sensitive to soil and microclimatic differences. Morover, the two layers usually react quite differently to external interferences.

With few exceptions, one tree species is usually competitively superior to all others on a given site. Thus, it is capable of displacing all others over time and in the absence of interference, and will tend to form pure stands. However, a condition of no interference is more theoretical than real. The significance of recognizing this principle lies in an understanding of why tree species are distributed as they are and what changes can be expected under various conditions of interference.

The principle does not apply in the same way to understory aggregations. While competition is an important factor in community development, the effects of competitive exclusion are usually evident only in opportunist species that have invaded or increased following disturbances. Climax herbaceous and shrubby species can and usually do grow together on a given site as a stable community.

In the study area, the effects of wildfire are much more evident in the existing overstory than in the understory. Conversely, the effects of grazing are most evident in the understory and have had little influence on the distribution of overstory species.

It is also important to recognize that the relationship of existing vegetation to soil type is rather weak. This is particularly true of species distribution in the overstory but is also generally true of understory community distribution. The reason is that vegetation can be strongly influenced by external factors as discussed above and that the soil properties to which plant roots are sensitive are not those on which soil classification is ordinarily based. It is only at higher levels of aggregation that useful correlations can be developed. While the environmental amplitudes of a given species may often terminate on a soil classification break, they usually encompass several such classification

Correlation of vegetation units to land type units is somewhat more effective. This is because land type classification considers a number of other environmental characteristics such as zonal climate, landforming processes, and slope/aspect that also influence vegetation development. As previously discussed in this paper, a reasonable correlation exists on the study area between aggregated vegetation units and land type groups.

A comparable correlation between plant community types, either existing or potential, and land types or soil types is less likely.

For purpose of stratification, plant community types are described in terms of present structure and composition and are discussed in terms of their relationships to each other and to potential communities. Incidental and localized openings in forested types are included as a part of the natural aggregation.

Some of the larger meadow openings, canyon fill areas, and other non-forested types are described separately as are a number of the alpine and subalpine communities. A total of 29 plant community types have been tentatively identified in the study area.

Descriptions for most of the community types are based on data from specific sites presumed to be representative of the types. Some are based on composites of data from several related sites and a few are based only on cursory observations. Existing data from range environmental analysis and other sources were used where possible but most of the data was obtained through field investigations. The following descriptions are made independently of other classifications.

A Tentative List of Plant Community Types Grouped by Broad Overstory Characteristics (see Appendix / )

## Lodgepole Pine

1. Lodgepole pine/pinegrass
2. Lodgepole pine/grouse whortleberry
3. Lodgepole pine/ tall huckleberry
4. Lodgepole pine/beargrass

## Douglas-fir

5. Douglas-fir/pinegrass
6. Douglas-fir/tall huckleberry
7. Douglas-fir/mixed shrub

## Aspen

8. Aspen-Lodgepole pine
9. Aspen scrub
10. Aspen woodland

## Spruce-fir Subalpine Zone

11. Spruce-subalpine fir forest
12. Tall forb parkland

## Whitebark-limber Pine

13. Whitebark-limber pine/tall forb
14. Whitebark-limber pine
15. Subalpine barrens

## Alpine

16. Alpine tundra
17. Alpine barrens
18. Alpine slopes
19. Alpine meadows

Azonal and Miscellaneous

20. Mixed tall shrub brushfield
21. Curlleaf mountain-mahogany
22. Ceanothus
23. Willow
24. Upland sagebrush
25. Bottomland sagebrush
26. Wet meadow
27. Aquatic
28. Cold Spruce
29. Mixed conifer/mesic shrub valley bottom

The Lodgepole Pine Complex

Lodgepole pine is the principal overstory dominant in the plateau area at the present time and occupies a substantial part of the mountain area as well. Eighteen individual sites were investigated where lodgepole pine was the overstory dominant. These sites represent most of the community type variation that was observed in lodgepole pine in the study area. They, along with literature reviews, serve as the basis for the interpretations which follow (see Appendix 2 ).

Most of the lodgepole pine stands in the study area fall in the 80 to 100-year age range. Only one stand of an older age was investigated (120 years old). A number of younger stands can be found and they are invariably associated with more recent wildfires of record. Bark-beetle depredations were observed to relate most closely with the larger-sized stands and individuals in the lower and mid montane zone.

Without exception, the understory vegetation was dominated by one or a combination of six species. These are: pinegrass (Calamagrostis rubescens), tall huckleberry (Vaccinium membranaceum and V. arbuscula), low whortleberry (Vaccinium scoparium and V. caespitosum), and elk sedge (Carex geyeri). One area is unique in that beargrass (Xerophyllum tenax) is an important subdominant in the understory. This species was not observed elsewhere in the study area.

Analysis of the available data has not yet identified clearcut relationships between understory communities and stand and site characteristics. However, there is little question that such relationships do exist. Additional data analysis would be highly desirable,

On seven of the lodgepole pine sites investigated, lodgepole pine is reproducing successfully with a near exclusion of other tree species. On these sites, lodgepole pine will clearly succeed itself in the overstory. On five sites, Douglas-fir is reproducing successfully to the exclusion of other tree species. These sites will revert to their original Douglas-fir cover in one overstory generation if the successional trend is not interrupted. On two sites, no reproduction is currently taking place and a change in stand structure and density will have to occur before significant amounts of reproduction of any kind will succeed. On the remaining sites, successful reproduction of more than one species is occurring. Douglas-fir is successful on all of them, subalpine fir on two, and lodgepole pine on one.

By extrapolation of these findings and gross observations of the plateau area in general, it appears that lodgepole pine will succeed itself on about one-third of the forested area, Douglas-fir will succeed lodgepole pine in one overstory generation on about one-third of the area, and subalpine fir or Douglas-fir will succeed lodgepole pine in about two or three overstory generations on the remaining third. These extrapolations assume an absence of interruption -- a condition more academic than real -- but knowledge of such trends in overstory dominance should be useful in guiding future management activities.

Because the relationships between overstory and understory in the lodgepole pine complex are still unclear, the community type descriptions which folow are separated on the basis of gross differences in understory composition. Further study may show these groupings to be inappropriate.

1. Lodgepole pine/pinegrass (see sites WST-2, -16, -17, -18, -19, -20, -24, -42, -43, -45, and WST-46)

The pinegrass type usually occupies the lowest elevational position among the lodgepole pine community types in this area. The type gives an impression of neatness due to the uniformity of overstory and the park-like sward beneath. It is of widespread occurrence in the plateau area and is most often associated with gentle topography.

The overstory is typically pure lodgepole pine of uniform height and moderately dense spacing. The canopy density ranges from 50 to 75 percent. On most of the sites investigated, lodgepole pine was clearly succeeding itself but on three sites it was being succeeded by Douglas-fir.

Pinegrass is usually strongly dominant in the understory but sometimes grouse whortleberry is also quite abundant. Occasionally, tall huckleberry is plentiful. The most common herbaceous associates are heartleaf arnica, sweetanise, meadowrue, sticky geranium, and yarrow.

This community type is the scene of a substantial part of the current bark beetle depradation, due primarily to the uniformity of tree size and age. A large proportion of the trees in most stands fall in the 8 to 15 inch diameter size class. This is the stage in which they are most vulnerable to bark beetle attack.

2. Lodgepole Pine/grouse whortleberry (see site WST-9 and WST-10)

This is probably the least productive of the lodgepole pine community types. It occupies two elevational zones; (1) immediately above the pinegrass community type and (2) at higher elevations where lodgepole pine is a disclimax to subalpine fir. It is thought to be usually associated with shallow soils. The overstory is typically pure lodgepole pine in rather dense slow growing stands. The type is succeeded by either Douglas-fir or subalpine fir in one generation and reproduction in the type is mostly of these latter species. The lower elevation segment of the type is involved in the current bark beetle infestation.

The understory is dominated by grouse whortleberry of sparse to dense cover. Utah honeysuckle and spirea are common shrub associates and tall huckleberry sometimes occurs. Elk sedge is usually fairly abundant but pinegrass is sparse or absent. Heartleaf arnica, fireweed and hawkweed are the principal forbs.

Some stands have a mixture of grouse whortleberry and pinegrass in the understory. These are more typical of the pinegrass type than of this one.

3. Lodgepole pine/tall huckleberry (see sites WST-21, 22, 33, and 34)

This is one of the more common community types in the study area and is a disclimax stage of the Douglas-fir/tall huckleberry type. It probably represents a more mesic condition than does the other lodgepole pine types. Most of the lodgepole pine stands in the mountainous area appear to be of this community type.

Crown densities are usually in the range of 60 to 85 percent and understory yields seldom exceed 500 to 600 pounds dry weight per acre. Tall huckleberry is the understory dominant. Utah honeysuckle and spirea are common shrub associates and grouse whortleberry sometimes occurs in moderate amounts. Forbs are unimportant in the type with heart leaf arnica being the principal representative. Pinegrass is a common herbaceous member. Elk sedge may also be important at times.

It is in this type and its Douglas-fir equivalent that occasional small openings are occupied by the ceanothus community type as a seral stage following wildfire.

4. Lodgepole pine/beargrass (see sites WST-9 and WST-11)

Beargrass was observed to occur in only one small part of the study area. This was in the northeastern part of the plateau area in the headwaters of North Boone Creek, Calf Creek, and Cascades Creek. The area has been glaciated, both scouring and deposition, and is subalpine in character. Existing lodgepole pine overstory is seral to subalpine fir in this area. Both Douglas-fir and subalpine fir are reproducing successfully. Except for the presence of beargrass, this type is essentially synonymous with the upper elevation expression of the lodgepole pine/grouse whortleberry community type.

Beargrass is well represented in the understory with grouse whortleberry and tall huckleberry alternately occurring as codominants.

Whortleberry is the more frequent of the two. Elk sedge and arnica are usually present. Pine grass, Utah honeysuckle, pipsissewa, spirea, and hawkweed occur sporatically.

The reason for the occurrence of beargrass in this limited area is not clear. In other areas it has been observed that beargrass is associated with shallow ground water flows. This would suggest a shallow to bedrock condition developed through glacial scouring. However, Daubenmire (1968) concludes that its presence is related to critical soil drought conditions. The matter needs further study.

The Douglas-fir complex

Douglas-fir is the principal climax overstory species of the study area. It is the potential natural dominant of most of the plateau area and the montane zone of the mountainous area. Many of the Douglas-fir sites are currently occupied by seral lodgepole pine, particularly in the plateau area. However, in most cases, living or dead Douglas-fir stand remnants can be found in the form of decadent veterans, occasional mature trees, stumps, down logs, or charred remains. Douglas-fir reproduction under the lodgepole pine canopy is common on many sites. Existing Douglas-fir stands are typically uneven-aged with all age groups from seedling through overmature and decadent being well represented. An occasional exception was noted wherein a new even-aged stand was regenerated following catastrophic wildfire. Even these will become mixed-aged over time. Typical mature dominants in several stands are 120-130 years old while the decadent veterans are about 200 years old.

Three community types are described on the basis of available data. However, the considerable overlap in understory species composition suggests that additional investigation is needed

5. Douglas-fir/pinegrass (see site WST-36)

The literature reports the Douglas-fir/pinegrass community to be the most common and widespread of the climax Douglas-fir community types. However, it is the ~~latest~~ least common in the study area. This is probably because most of the type in this area has been converted to a lodgepole pine overstory due to periodic wildfire.

The type is characteristically nearly shrub free although myrtle pachistima is sometimes fairly abundant. The understory is strongly dominated by pinegrass with elk sedge, heartleaf arnica, sticky geranium and a few other species as principal associates.

6. Douglas-fir/tall huckleberry (see site WST-32)

This is the most common of the Douglas-fir community types in the study area. Its understory is a mixed shrub community in which species of huckleberry dominate. Associated shrubs include Utah honeysuckle, myrtle pachistima, serviceberry, russet buffaloberry, Scouler willow, creeping barberry, and mountain ash. Pinegrass is an important constituent in the understory. Meadowrue, fireweed, sickletop pedicularis, and pipsissewa are the principal forbs.

Subalpine fir may occur in the overstory but its reproductive success is marginal whereas Douglas-fir reproduction is very abundant. Lodgepole pine occurs occasionally as a seral member. The overstory is readily converted to lodgepole pine for one generation following an intense wildfire but the understory is affected for only a few years by such an event.

This type appears to occupy cooler, more moist sites than does the mixed shrub type in which huckleberry species are absent.

7. Douglas-fir/mixed shrub (see sites WST-14 and WST-37)

This community type is characterized in the understory by an abundance of snowberry and white spirea and an absence of tall huckleberry and grouse whortleberry. Pinegrass is also abundant in the understory. The type usually includes several other shrub species such as, service-berry, chokecherry, creeping barberry, currant, bearberry honeysuckle, myrtle pachistima, and mountain ash. Common herbaceous associates are heartleaf arnica, sticky geranium, blue wildrye, meadow-rue, mountain brome, sweetanise and engelman aster.

The Douglas-fir overstory is of mixed-age including scattered decadent veterans, intermediate ages, and plentiful saplings. The reproductive success supports the view that this is a climax community type. Even so, there is clear evidence of ancient wildfire. Lodgepole pine may sometimes occur as a seral member of the overstory.

Apparently the community affords optimum habitat for pine squirrels as they were observed to be noticeably more abundant here than in any other community in the study area.

8. Aspen-Lodgepole Pine (see site WST-13)

The major expression of this type is in the northwestern portion of the plateau area (an area of gently undulating terrain) where it appears to form an ecotone between a formerly much broader aspen belt and the coniferous montane forest. No doubt some of the mixing of the two overstory species is a result of ecesis along the common boundary of the zones. However, it seems mostly to be an expression of fire-induced competition. Since both lodgepole pine and aspen act as seral opportunists in the Douglas-fir montane, they can readily be thrown together in competition as a result of wildfire or other disturbance. Assuming both are present and have equal opportunity, their respective successes depend upon the characteristics of each individual disturbance. These vary with each succeeding event, favoring first one species and then the other and a mixture of the two results. Since both are relatively short-lived, the overstory element of this type is exceptionally dynamic and constantly changing over time.

Aspen and lodgepole pine trees of apparently similar ages (50 to 75 years) sometimes occur as co-dominants but, more often, occur as inter-mixed micro-communities wherein aspen is most abundant on ridge

positions and lodgepole pine in the swales. Occasional Douglas-fir remnants and pole-sized trees occur. While reproduction is scarce, all three species show some success. In the absence of future disturbance, Douglas-fir will eventually succeed on these sites but this is an unlikely event. Even minor disturbances will simply revitalize the dynamic relationship between the species.

The understory is not greatly modified by the interplay of the overstory species since neither can control the site completely enough to alter micro-site characteristics but the composition has been modified by past livestock grazing. It is currently dominated by pinegrass, heartleaf arnica, and snowberry. Associated species of importance are meadowrue, sticky geranium, serviceberry, starwort, fireweed, lupine, false solomon-seal, rose, spirea, sweetanise, and bedstraw. It was observed that as stand composition shifts from aspen to lodgepole pine, snowberry tends to diminish and heartleaf arnica to increase.

9. Aspen Scrub - (See sites WST-27, WST-40, and WST-41)

This type is rather widely scattered over the study area. It is common on the colluvial frontlands (scarp faces), on colluvial slopes between exposed sedimentary bedrock strata in the canyons, on sideslopes in upper Boone Creek, and on localized sites throughout the montane zone. A common site characteristic seems to be that of relative mass instability on fairly steep slopes.

The type is characterized by rather dense stands of aspen of a near shrub-like life form. Individual stems are short-lived and often decadent but abundant sprouting maintains aspen on the site. Apparently, movement of the unstable subsoil mantle abrades the aspen root system causing both poor growth quality and abundant root sprouting. Conifer was not observed to be making any successional inroads into these stands. The type can probably perpetuate itself indefinitely if the basic cause continues.

Herbaceous understory yields are moderately high (600 to 1,500 pounds dry weight per acre) and surface conditions are usually fairly stable. Species composition is a diverse mixture of grasses, forbs and shrubs. The dominant understory species are slender wheatgrass, myrtle pachistima, geranium, elkweed, mountain brome,

snowberry, heartleaf arnica, oneflower helianthella, chokeberry, and serviceberry. Important associated species include kentucky bluegrass, elk sedge, engelmann aster, nuttall aster, arrowleaf balsamroot, yampa, horsemint, rose, creeping barberry, yarrow, hawkweed, and lupine.

10. Aspen Woodland - (see sites WST-12, WST-29, and WST-38)

This type is usually associated with deep well-developed soils and mesic conditions. The overstory is of well-formed trees. The type is highly productive of herbage with yields in the range of 1,000 to 2,000 pounds dry weight per acre. Larger aspen trees are about 65 to 70 years old. Ground cover of vegetation and litter is near 100 percent. Aspen is regenerating as rapidly as overstory members drop out. There was no evidence of conifer encroachment into the stands investigated.

The understory is a lush tangle of vegetation of three layers -- an upper layer of tall shrubs, a mid layer of tall forbs, and a lower layer of pinegrass. Dominant understory species are pinegrass, snowberry, lupine, meadowrue, engelmann aster, sticky geranium, serviceberry, myrtle pachistima, trailing clematis, elk sedge, heartleaf arnica, and snowbrush ceanothus. Associated species include blue wildrye, sweetanise, fireweed, spirea, willow, maple, ballhead waterleaf, false solomon-seal, bedstraw, yarrow, chokecherry, rose, and creeping barberry.

Spruce-fir subalpine zone

The community complex described here is found in the middle and lower subalpine zone and throughout the often broad ecotone between the subalpine and montane zones. Its general appearance ranges from one of a forested aspect with scattered open parkland to one of open parkland with scattered clumps of trees. The complex is treated here as two community types even though they are intermixed in a variety of ways.

11. Spruce-subalpine fir forest (see site WST-7)

This community type represents the forested portion of the parkland complex. It ranges from rather large expanses of dense forest to very small scattered clumps of trees. It usually consists of engelman spruce and/or subalpine fir with occasional individuals and stands of whitebark-limber pine and is considered a climax community type of the subalpine zone. Lodgepole pine is common as a disclimax member.

Tree reproduction is usually plentiful but the herbaceous understory is typically sparse, ranging from near zero to a yield of 200 pounds dry weight per acre. Grouse whortleberry is the most common and widespread component of the understory. Heartleaf arnica, elk sedge, bracted and sickletop pedicularis, and coralroot are typical herbaceous members. Tall huckleberry occurs occasionally. Abundant needle litter and moss often provide a ground cover of near 100 percent.

Seral lodgepole pine in the type is usually of only one generation duration as stands although scattered individuals may persist.

12. Tall Forb Parkland (See sites WST-5, WST-6, and WST-8)

The nonforested openings in the spruce-subalpine fir forest are typically occupied by a lush tall forb community type. The same community may also occur as an understory in open stands of Douglas-fir or subalpine fir. The type is characterized by a large variety of forb species that vary from place to place primarily in the distribution of dominants in the composition. Not all species occur on every site but many of them do. Grasses seldom achieve much importance in the composition although a small group of grass species are quite consistent as sparse members of the community. The type usually includes a few shrubs which may sometimes become more prominant as the type gradiates into shrub dominated understories of adjacent forest.

Some shift of species can be detected between the mountainous and the plateau parts of the study area. Likewise, there is some shift on an elevational gradient. However, the changes are small and do not alter the general nature of the community type.

Herbaceous species which are usually found in moderate abundance include: engelmann, leafybract and thickstem asters, fernleaf ligusticum, hawkweek, fleabane, horsemint, sticky geranium, thick-leaf and lambstongue groundsel, bluebell, lupine, bracted and sickletop pedicularis, oneflower helianthella, northwest and gland potentilla, fireweed, meadowrue, duncecap larkspur, and orange agoseris, Many other species occur in lesser amounts.

The type is important for forage production with herbaceous yields often exceeding 1,500 pounds dry weight per acre. Past grazing by domestic livestock (primarily sheep) has often modified the type by reducing taxonomic diversity and causing a shift toward "few species" dominance (see appendix 4 ). In some cases past sheep use has reduced the forb component and grass species such as subalpine needlegrass, elk sedge, Wheeler bluegrass, and slender wheatgrass now dominate the site.

The tall forb community type is considered to be climax in this zone. However, some evidence (Patton, 1963) indicates that it may represent the remains of vegetation patterns produced during a xerothermic period following glaciation. The cool, moist climate since then has allowed forests to invade upon those sites where soil moisture and aeration were favorable for tree species. If the hypothesis is correct, continued encroachment of conifers into the tall forb type can be expected but it will be a very slow process. Wildfire may also have been an important factor in creating the present forest pattern.

Whitebark-Limber Pine

This complex can be separated into three rather distinct community types, all occurring at higher elevations (usually in the mid and upper subalpine).

13. Whitebark-limber pine/tall forb - (see site WST-6)

This type is characterized by a moderately dense overstory of whitebark-limber pine but usually includes some lodgepole pine, engelman spruce, and subalpine fir members. The understory is

a herbaceous layer, predominantly forbs, that is very much like the unforested tall forb park type. Important understory species include engelmann aster, fleabane, lupine, sticky geranium, slender wheatgrass, mountain brome, thickleaf groundsel, thickstem aster, cinquefoil, and fireweed. Numerous other species occur in lesser amounts.

14. Whitebark-limber pine

This type has a sparse to moderately dense overstory of whitebark-limber pine with occasional lodgepole pine, engelman spruce, or subalpine fir. The understory ranges from sparse to virtually nonexistant and extensive patches of exposed mineral soil are common. It is usually found on weakly developed soils that are shallow to bedrock.

15. Subalpine barrens

This expression of the type can hardly be called a plant community. It is characterized by large expanses of barren bedrock with occasional whitebark-limber pine, spruce or subalpine fir of stunted appearance surviving in rock fractures and in occasional pockets of soil material. The understory consists of occasional and widely scattered pioneer species of grasses, forbs, and shrubs. This type represents a very early stage of successional development.

Alpine

The upper elevations of the study area include several basins near timberline and a number of ridges and peaks that extend well above timberline. The vegetation and its setting is

generally alpine in character although only a few areas can be defined as true alpine. Four general plant community groupings are included here.

16. Alpine tundra (ridges with predominantly alpine species).
17. Alpine barrens (essentially nonvegetated).
18. Alpine slopes (predominatly alpine species).
19. Alpine meadows (in the upper subalpine basins).

Mont Lewis (Lewis, 1957) prepared a description of the vegetation of these alpine-subalpine plant communities which is accepted for purposes of this paper.

20. Mixed Tall Shrub Brushfield - (see sites WST-26 and WST-39)

This type represents a seral or successional stage following the destruction of uneven-aged Douglas-fir/mixed shrub type. It most commonly occupies southerly exposures in the mountainous area. It has a three-layer structure consisting of (1) scattered residual Douglas-fir trees and/or overtopping regrowth, (2) a profuse mixture of tall shrub species, and (3) a herbaceous layer, mostly of tall forbs, with dry weight yields in the range of 1,000 to 2,000 pounds per acre. Sometimes, low shrub species form a significant fourth layer.

The tall shrub layer is dominated by species such as chokecherry, serviceberry, Rocky Mountain maple, mountain-ash, snowbrush ceanothus, trailing clematis, rose, currant, and gooseberry.

The common species of the herbaceous layer are horsemint, showy goldeneye, arrowleaf balsamroot, butterweed groundsel, mountain brome, sticky geranium, lupine, oneflower helianthella, sweetanise, engelmann aster, fireweed, meadowrue, phacelia, and many other forbs and grasses in lesser abundance.

The low shrub layer, when present, is made up of myrtle pachistima, creeping barberry, snowberry, and occasional big sagebrush.

Over time, the type will be gradually restocked with Douglas-fir and will eventually revert to the Douglas-fir/mixed shrub type. In its seral status, it is productive of a wide array of habitat niches for faunal species. It is one of the most productive types in this regard.

21. Curlleaf Mountain-Mahogany - (see sites WST-28, WST-30, and WST-31)

The curlleaf mountain-mahogany type is of minor occurrence in the study area, being confined to certain well-drained south exposure colluvial slopes associated with limestone/dolomite cliffs but it appears to fill an interesting site niche. Ecologically, it occupies xeric sites in the midst of a generally mesic region. Soils are stony, immature and droughty in character. The community was observed in the lower canyon areas of Moose Creek and Darby Creek and probably also occurs in other canyons.

Similar topographic situations are variously occupied by the curlleaf mountain-mahogany, aspen scrub, and Douglas-fir/shrub communities

depending upon the relative mass stability and soil moisture retention capabilities of the site. Mahogany occupies the drier, more stable unit of this sequence, with Douglas-fir on the mesic stable sites and scrubby aspen on the mesic sites with mass instability.

The mahogany community does not appear to be fire induced nor to have been much influenced by domestic livestock grazing. Biotic stresses induced by mule deer, rabbits, tent caterpillars, spiny silk worms, and measuring worms are known to influence some stands.

The community is characterized by relatively pure stands of mountain-mahogany in the overstory. Canopy density is typically about 40 percent. Herbaceous understory yields are in the range of 800 to 1,200 pounds dry weight per acre. The principal understory dominant is bearded bluebunch wheatgrass. Arrowleaf balsamroot, showy golden-eye and oneflower helianthella are also abundant. Important, but less abundant, associated species include big sagebrush, creeping barberry, snowberry, and meadowrue.

Observations in a number of areas indicate that curlleaf mountain-mahogany may often be xéric equivalent to Douglas-fir on sites derived from limestone parent materials. Such seems to be the case here. Of even more interest in this area is the apparent successional relationship between mahogany and Douglas-fir (see Appendix 5). Variants of the community type were found which represent several stages of this succession including one which is best described as a Douglas-fir/mahogany/bluebunch wheatgrass community.

22. Ceanothus

This community is but sparcely represented in the study area. It usually occurs as small dense thickets of snowbrush ceanothus within the Douglas-fir/mixed shrub type. It is found on stony ridges and southerly exposures. The type is seral or disclimax and is the result of particular site and environmental conditions related to burning in the Douglas-fir type.

Gratkowski (1962) and Lyon (1966) found that viable ceanothus seed frequently persists for many decades and that a temperature in excess of 140° F followed by a cold period is necessary for its successful germination. The species must also compete with other seral species following wildfire. Thus, only an occasional burn results in the combination of conditions that establish this community. The community was not investigated in detail during this study and no further characterizations are made.

23. Willow

Rather large areas of bottomland willow type occur in the north-central part of the plateau area and to a lesser extent elsewhere in the study. The type is commonly associated with wet meadows and is probably a developmental phase of the meadow community.

The willow community type was not investigated and is not described in this paper.

Sagebrush - (see site WST-25)

Areas on which sagebrush species give the general aspect can be separated into two groups -- the upland sagebrush type and the bottomland sagebrush type. Neither are of much areal extent in the study area but they are of value because of the contrasting diversity they provide in a generally forested landscape.

24. Upland Sagebrush

Upland sagebrush occurs as island-like areas within or fingers extending into the forested zone at mid-elevations, It owes its existance to particular soil and microclimatic characteristics that create droughty conditions within a more humid zone. The sites are not readily adapted to the coniferous species common to adjacent sites. Probably soil surface temperatures are high enough to be fatal to conifer seedlings but other factors may be involved as well. The community type is usually found on south exposure slopes and ridges and is closely similar to the sagebrush type of the unforested basal plains which lie adjacent to the base of the mountains.

25. Bottomland Sagebrush

This expression of the sagebrush type occurs in many of the lower canyon fills where it occupies alluvial and outwash bottomlands and colluvial toe slopes. Sagebrush species provide the present aspect or are, at least, an important component of the present vegetal composition. The type represents a regression stage on what were

formerly wet and dry meadow sites. The deterioration is illustrated by current abundance of intermediate and least desirable species such as butterweed groundsel, coneflower, mullein, knotweed, kentucky bluegrass, goldenrod, geranium, yellowbrush, and goatsbeard. Some of the more desirable species common to the type are snowberry, junegrass, oneflower helianthella and Great Basin wildrye.

The deterioration that results in this type can generally be attributed to management actions that rejuvinate stream downcutting and lower the ground water levels and/or to improperly managed livestock grazing. In either event, the result is site desication. Potential yield of 1,000 to 2,000 pounds dry weight per acre is possible but a change in composition is often necessary to achieve it. The characteristics of this community type can be expected to change if the stresses from livestock use are relieved. Kentucky bluegrass will probably increase on the alluvium while shrub species will tend to increase on the more stony sites. The original mesic site conditons are not likely to return for a long time unless a more favorable ground water stream channel regimen is restored.

26. Wet Meadow

Numerous wet meadows of various sizes occur throughout the study area. They are most prevalent in the northcentral and northwestern portion of the plateau area where they are frequently associated with lakes and potholes.

These communities were not investigated so the type is not described in this paper.

27. Aquatic Communities

No attempt was made to characterize aquatic communities or to otherwise deal with aquatic ecology. Nonetheless, the importance of these kinds of ecosystems and their relationship to many faunal species is recognized. For example, Indian Lake with its abundance of emergent and floating vegetation provides an important habitat niche for waterfowl and other wildlife species.

28. Cold Spruce

Cold spruce is a discontinuous community occupying some sites along streams as well as cold air pockets and moist coves on the slopes at upper elevations. Its occurrence is controlled by unique microclimatic factors that are independent of exposure or elevational position. It is composed of mature engelman spruce and subalpine fir growing in small but dense patches. Understory is either absent because of a thick litter layer and dense forest canopy, or is composed of mosses, ferns, spruce and fir reproduction, and a few forbs and shrubs such as currant, gooseberry, meadowrue and heartleaf arnica.

29. Mixed Conifer/Mesic Shrub Valley Bottom

This rather poorly defined community type was observed in some of the moist shady valley bottoms along perennial streams. Its best expression is in lower Moose Creek near the road end. The overstory consists of a loose mixture of mature Douglas-fir, lodgepole pine, engelman spruce, aspen, and subalpine fir trees of moderate to high crown density. No single species shows any present tendency toward site dominance.

The understory is very brushy and consists mostly of a large variety of tall and low shrub species, again with no current expression of dominance. On the Moose Creek site, a total of 27 shrub species were identified. Listed in alphabetical order these were:

| | | |
|---|---|---|
| Acer glabrum | - | Rocky Mountain maple |
| Alnus tenuifolia | - | thinleaf alder |
| Amelanchier alnifolia | - | service berry |
| Berberis repens | - | creeping barberry |
| Cornus stolonifera | - | dogwood |
| Lonicera involucrata | - | bearberry honeysuckle |
| Lonicera utahensis | - | Utah honeysuckle |
| Pachistima myrsinites | - | myrtle pachistima |
| Potentilla fruticosa | - | shrubby cinquefoil |
| Prunus virginiana | - | chokecherry |
| Ribes cereum | - | wax currant |
| Ribes lacustre var. parvulum | - | prickly currant |
| Ribes viscosissimum | - | sticky currant |
| Rosa woodsii macounii | - | rose |
| Rubus parviflorus | - | thimbleberry |
| Rubus idaeus var. strigosus | - | red raspberry |
| Sambucus cerulea | - | blueberry elder |
| Sambucus racemosa microbotrys | - | red elder |
| Salix sp. (three species) | - | willow |

| | | |
|---|---|---|
| Shepherdia canadensis | - | russet buffaloberry |
| Sorbus scopulina | - | mountain-ash |
| Spiraea betulifolia | - | spirea |
| Symphoricarpos occidentalis | - | snowberry |
| Vaccinium membranaceum | - | tall huckleberry |
| Vaccinium scoparium | - | grouse whortleberry |

The type may represent a frequently interrupted expression of the Douglas-fir/mixed shrub community type or it may be merely a mosaic of micro-communities. Present information is not adequate for further interpretations. However, the type is unique for the abundance and variety of shrub species found in it.

## PART IV - ECOLOGICAL INTERACTIONS, ECOSYSTEM FUNCTION, AND MANAGEMENT IMPLICATIONS

The study area and/or its component sub-areas should be thought of as a functioning biophysical system. We need to develop some understanding of how the system works if we are to successfully predict the results of alternative courses of action. This requires the identification and inventory of as many of the significant components which make it up as is possible. More importantly, we need to identify and investigate the significant processes and functions that couple various compartments of the system together.

For the present, this section is a loosely arranged aggregation of interpretative points that may have implication in management planning and decision making. Arrangement of the items is intended to aid in their location by subject matter. The section deals with community function in terms of dynamic responses of vegetation, floral-physical relationships, and some floral-faunal interactions.

At the bottom, this is a matter of interpretation. The statements are to be regarded as hypothesis or, in some cases, merely possibilities. I have used deduction to inform my judgments, and not to present irrefutable facts. Most of the findings presented herein are in need of -- and probably deserving of -- additional study through which some of them may be refuted. Nonetheless, the pointing out of possible interactions and relationships should be of value in predicting consequences of potential management alternatives. It has been said, "the only way to

command Mother Nature is by obeying her. But even before we can command or obey, we must understand."

Lodgepole Pine

Hague, Iddings, Weed, et al (1899) report evidence of lodgepole pine occurrence in Tertiary times in the Yellowstone Park area. It can be presumed that it also occurred in the study area at that time and since and that it has been constantly present in the genetic pool throughout the successional development of modern vascular flora in this area.

Therefore, in this discussion of the species, the issue is not one of occurrence. The questions of concern relate to spacial distribution, competitive relationships, population dynamics, and other like questions about the species. Knowledge, even though deductive, of the behavioral characteristics of this species is needed to rationally plan management actions in those areas where it is a significant constituent of the flora. This is the case in much of the study area.

The occurrence of lodgepole pine is by no means haphazard and is explainable in terms of a number of factors. The crux of useful interpretive work requires that these factors be identified and their relative importance be evaluated on a situation by situation basis.

1. Lodgepole pine appears to play four roles in community patterns in this area.

a. As a fire-induced seral stage of spruce subalpine fir type in the subalpine zone and the montane ecotone.

b. As a fire-induced seral stage of Douglas-fir type in the montane zone.

c. As a direct seral competition with aspen in the lower montane and foothill zone.

d. As a pyric climax on certain sites in the mid and lower montane zone.

2. Lodgepole pine/grouse whortleberry type in the upper part of the lodgepole pine belt are usually a disclimax of the subalpine fir association and will be replaced by it over time. Bark beetle attacks are less pronounced here but mistletoe infestations appear to be more prevalent.

3. Lodgepole pine shrub (either tall huckleberry or mixed) is usually disclimax to the Douglas-fir association and will be replaced by it over time. Bark beetle infestations now prevalent in this type tend to favor Douglas-fir regeneration over lodgepole pine.

4. Lodgepole pine/pinegrass and lower elevation lodgepole pine/grouse whortleberry are in the natural Douglas-fir zone but lodgepole pine has now become a pyric climax due to the periodic repetition of wildfire (apparently for centuries). Lodgepole pine will continue to succeed itself on many of these sites for a long time even if wildfire is not repeated. Present bark beetle depredations tend to center in these types. If left unmolested the effect of bark beetle kills is to favor Douglas-fir regeneration in those places where seed source is still readily available.

5. Lodgepole pine will tend to achieve dominance on aspen lodgepole pine sites if these sites are protected from further disruption. As this occurs, the understory will tend to shift more to species such as pinegrass, arnica, and pachistima. Douglas-fir could eventually occupy these sites.

6. Even-age lodgepole pine stands generally decimate and break up at about 100 years of age. This is due to increasing susceptibility to bark beetles and a variety of tree diseases. A majority of stands in the study area are approaching this age.

7. Roe and Amman (1970) report that susceptibility to beetle buildup in lodgepole pine is related to thickness of phloem and hence to size of trees as a generality. Large beetle infestations are dependent on the presence of an abundance of larger diameter trees within the lodgepole pine stand. Rate of infestation is inverse to elevation suggesting lodgepole pine is most susceptible in the Douglas-fir zone.

They also report an apparent relationship of beetle susceptibility to mistletoe intensity. Mistletoe tends to higher occurrence as elevation increases. Data from Moose Creek plateau, Targhee National Forest, indicates that thickness of phloem is significantly reduced in lodgepole pine for trees moderately to heavily infested with dwarf mistletoe.

8. Horton (1958) reported that open-grown lodgepole pine shows about a 1:1 ratio of maximum lateral root length to stem height for the first 20 years. This evidence, when coupled with the findings of Zinke (1962) concerning changes in soil chemistry associated with crown effect, demonstrate the very major influence that a dense even-aged stand of lodgepole pine can impose upon the physical characteristics of its site.

9. The large clear cut areas created by salvage timber harvesting of beetle killed lodgepole pine have modified site characteristics in a major way through increased light intensity, altered soil chemistry, and increased herbaceous competition. Restoration of coniferous forest cover on these sites will be slow and difficult. Opportunities for Douglas-fir regeneration are largely eliminated.

10. Lodgepole pine stands decimated by bark beetle result in an environment that favors displacement of ladgepole pine and encourages the establishment of Douglas-fir at lower and subalpine fir at higher elevations. Wildfire or logging disturbance introduced into this cycle tends to reverse the successional pattern and favor reestablishment of lodgepole pine.

11. Natural decimation of lodgepole pine stands at about 100 years of age is apparently a common and widespread phenomenom although individual trees are known to become much older and some stands of much greater age are known from other areas. Thus, the absence of older stands in the study area is not so suprising, but the strong preponderance of stands at a common stage of ecological development (75 to 100 year age class) is uniquely interesing. Available evidence does not clearly indicate antecedent causes for this condition but the wildfires of 1879 were apparently significant. Early-day timber harvesting activities were also a probable influence. The situation now poses a definite potential for catastrophic event as natural processes attempt to restore stability.

12. Patten (1963) found in the Madison Range in Montana, that lodgepole pine dominated forests are associated with areas of igneous rock parent material while the limestone parent materials tend to remain in the climax Douglas-fir forest. The specific attributes of the soil and site which cause this correlation are not known but the same general relationship is apparent in the study area.

13. The limited area in which the beargrass community is found is of special interest because of its uniqueness. Small wildfire clearings would tend to increase the abundance of beargrass on these sites.

14. Normal longivity of Douglas-fir in this area is 200 + years. Assuming a mixed-age stand of 600 trees per acre, successful regeneration of only three trees per acre per year on the average will fully maintain the stand. Successful establishment of about 15 Douglas-fir seedlings per acre per year will usually convert the overstory from lodgepole pine to Douglas-fir within a few decades.

15. Basile and Jensen (1971) found that site index for lodgepole pine accounts for only one percent of the variation in herbaceous yield. Measures of site potential for tree growth are not closely related to the production of associated understory vegetation. Apparently filled capacity and exchangeable potassium have substantial effect on understory yields.

16. Most sites with natural potential for Douglas-fir have a greater biomass productivity when occupied by mixed-age Douglas-fir stands than when stocked with even-age lodgepole pine stands.

17. A tree establishes in harmony with existing environment, then modifies that environment from effects such as shading the forest floor, intercepting rain and snow, reducing wind movement, utilizing soil moisture and nutrient materials, adding organic matter, cycling minerals, etc. When a portion of a stand dies or is removed, it again causes changes in light, temperature, moisture accumulation, soil moisture, etc., thereby creating a new niche in the environment. This niche is soon filled by new plants of the most adaptable available kind.

18. In general, a pure lodgepole pine forest will establish itself upon the remains of its burned predecessor wherever physical conditions have not been more favorable to another species. Within the altitudinal range of lodgepole pine, a number of other species may achieve local advantage and successfully occupy the burned site. In the lower part of the range, aspen may assume this role. Throughout the bulk of the range, other species that may be successful include Ceanothus velutinus, Abies lasiocarpa, mixed shrubs, and mesic forbs. Under proper conditions, Douglas-fir can frequently succeed itself. To some degree, a similar response can be expected following clearcutting, particularly if site scarification and slash burning are done.

The response of vegetation to bark beetle kill will usually be somewhat different since sites are left in a partly shaded condition and other physical characteristics are less altered. In such cases, shade-tolerant forbs and shrubs already present on the site will tend to increase. Douglas-fir reproduction will have a competitive advantage over lodgepole pine provided adequate seed source is available.

19. Ryker and Potter (1970) concluded that in those lodgepole pine stands which have Douglas-fir reproduction and/or a recent history of Douglas-fir, reestablishment of Douglas-fir is less likely if lodgepole pine is clearcut. Competitive advantage is shifted to Douglas-fir by a fairly heavy selective cut since Douglas-fir seedling survival will be enhanced by shading whereas lodgepole pine seedling survival will be reduced.

Wildfire

Current and historical evidence suggests that wildfire has been a very important influence in the creation of existing vegetation patterns. To date, I have found few places in the study area where a diligent search will not reveal some physical evidence of past fire.

Historical evidence gives inference to a cycle of major wildfire event at about half-century intervals. Patten (1963) refers to major wildfire occurrences in about 1770 and 1830 in the Yellowstone Park Area. These are presumed to have involved at least the plateau part of the study area. Tangible evidence cites major wildfire events about 1870 and in 1910. Extensive wildfire is reported in Teton Creek and the surrounding area in 1879 (Fryxell, 1932).

Brandegee (1899) described the forest and wildfire conditions of the Teton Forest Reserve as of 1897 to 1898 in the following way.

> "Only one-fourth of the area has trees and most of these are small and of inferior species. Fires have swept the country so completely and persistently that few areas are exempt and most have burned repeatedly within a generation. Most timber is small and sparse. Lodgepole pine has sprung up in dense thickets following fires but some areas have stocked to aspen after repeated burning. Not over 22,000 acres are of merchantable size."

A report by Graves (Brandegee, 1899) on the Black Hills Forest Reserve states that practically the whole area shows traces of fires with large occurrences separated by about half a centruy. Major wildfire events occured in 1730 to 1740, 1790 to 1800, 1842, 1875, and 1891 to 1893. These dates differ from those of the study area but the overall pattern is very similar.

One is lead to the conclusion that one of the most significant ecological relationships to be investigated is that of the lodgepole pine complex and the wildfire interactions as related to vegetation patterns and succession.

The successional development of vegetation following a wildfire event, although tending toward certain repetative patterns, is highly diverse. Many variables are associated with this phenomenom. Some of the more important seem to be:

1. Time of year and stage of vegetal development at which the burn occurs.

2. Meteorological events during the period prior to and following the fire.

3. Characteristics of the material being burned.

4. Available gene pool.

5. Character of the burn itself.

6. Physical characteristics of the soil and site.

7. Competative relationships and chance opportunity.

A hot, clean burn in Douglas-fir or subalpine fir will usually favor lodgepole pine or aspen regeneration, whereas, a cool, partial burn of Douglas-fir will usually favor Douglas-fir and/or shrub regeneration. Initial burn-followers are usually those on-site species that reproduce vegetatively, species with on-site seed supply that survive the fire, and/or species with wind-disseminated seeds.

A fire that thins the litter-humus layer or exposes mineral soil will usually favor coniferous over hardwood species because of the nature of the initial root systems.

It is more likely for extensive hot crown burns to occur on gentle topography. Rough country tends to interrupt fire runs and tend more toward ground fires.

One can also surmize that the failure of an area to burn periodically tends to increase the occurrence of mistletoe in that stand. This, in turn, tends to slow growth rates and, thus, delays or defers the

the susceptability of the stand to bark beetle depradation. In this manner, beetle-fire cycles may be interrupted in places and the diversity of the landscape is enhanced. The tendency to mistletoe is more prevalent in the upper elevation ecotone between Douglas-fir and spruce-fir zones, even though the site may be currently occupied by lodgepole pine. These events can bring about, through their influence on diversity and successional patterns in the vegetation, a profound effect upon the fauna through a dynamic flux in both habitat and food supplies.

Some unanswered questions pose interesting interpretive possibilities.

1. What are the differences in nature of wildfire in the mountain area vs. the undulating terrain of the plateau?

2. Would the nature of burn or the kind of material burned affect soil blackening in either amount or persistance and thus affect the competitive response of seedlings?

3. Could crown vs. ground fire in relation to residual live post-burn overstory and the resulting amounts of shading and/or litter replacement (kind or amount) influence the competitive ability of seedlings sufficiently to determine successional stand dominance?

Ahlgren and Ahlgren (1960) summarize their paper on the ecological effects of forest fires with the following points:

1. Fire has been frequent in forest, shrub, and prairie land for many centuries and has undoubtedly been a major factor in determining the direction and rate of plant succession.

2. In most cases, extensive, severe fires increase erosion by lowering the ability of the topsoil to absorb and retain water.

3. The ultimate effect of the changed moisture relationships on the water table apparently varies with different conditions and has not been investigated completely.

4. The temperature of the topsoil during fire varies greatly, but below two inches the temperature rise is not great. There are some reports that this heat causes direct changes in the texture and chemistry of the soil as well as direct stimulation or inhibition of plant germination and growth.

5. Very frequently, by removing the insulating plant life or blackening the surface of the soil, burning results in greater post-fire soil temperature extremes for some time after the fire. These extremes may affect plant growth.

6. Reports of the effect of fire on soil productivity range from decreased plant growth to greatly increased growth, and each must be considered individually.

7. The acidity of the soil is usually lower after fire. Generally there is also increased soil calcium, phosphorus, and potassium, but reports regarding increase and decrease in nitrogen are contradictory. Burning usually stimulates biotic nitrogen fixing activities in the soil.

8. Fire frequently results in an increase in moss, lichen, and liverwort cover, certain species being characteristic of burned areas.

9. Fire influences the spread or destruction of numerous insect pests and plant disease organisms. Here again, each case must be considered individually.

10. Definite patterns of post-fire plant succession exist, but these are different for different sites and conditions.

11. A vigorous regrowth of herbs, grasses and shrubs occurs frequently in the first few years following fire.

12. The effect of fire on tree reproduction varies with species, largely because of different methods of seed dispersal, seed survival, sprouting capacity and seedling requirements.

## Ecological Concepts With Management Implications

### 1. Antecedence

In the biological regime, every event has many antecedents. To designate a single antecedent as "cause" is strictly arbitrary and often misleading. Since antecedents are almost never quite the same even for apparently similar events, after effects can also vary. Lack of knowledge about antecedents of past events can lead to misjudgements in predicting the consequences of future actions. We need an understanding of the events that caused the ecosystem to be as it is and the forces and interactions that were involved. This is a good source of predictive information.

### 2. Diversity

Diversity relates to complexity of the components that make up the ecosystem. Usually the number of different species is assumed to be responsible for the entire diversity. This is only taxonomic diversity.

Species may differ taxonomically but belong to the same ecological group; a community may consist of representatives of very different ecological groups. The landscape itself may also be diverse or uniform. Diversity is directly related to ecosystem stability. This is because the greater variety reduces the likelyhood of an external interference affecting a significant portion of the ecosystem. It also increases the array of biological niches and alternate pathways that provide a damping effect on disruptions within the ecosystem.

3. Stability

Stability is defined as the ability of the ecosystem to maintain or return to its steady state after an external interference. The degree of stability is characterized by: (1) the amount of deflection from the steady state, (2) the rapidity of response to the interference, and (3) the rate at which any deflection is damped by the availability of alternate pathways in the functioning of the system as a whole. In a sense, stability can be equated with the health of the landscape. It should be an inherent goal in all wildland management planning.

4. Pattern

Pattern is defined as the spatiotemporal distribution of the vegetation component of the total ecosystem. It depends on environmental conditions, species morphology, interaction among species, and between species and the environment. Understanding pattern requires an understanding of concepts such as diversity and stability. It requires an appreciation for the ways in which patterns influence ecosystem function.

Management actions must deal with pattern in a very real way. On the larger scale, pattern affects problems of administrative-economic nature such as broad uses and output values (i.e. forested vs. nonforested). At medium levels it affects protection needs (i.e. susceptibility to insect and disease depredation, spread of wildfire, etc.) At the smallest scale, it affects such things as forest regeneration, rates of growth, herbaceous yields, wildlife habitat quality, etc.

Parts II and III of this paper are a start toward describing patterns within the study area.

5. Management Equilibrium

Once man has been injected into an ecosystem as one of the manipulating (controlling) forces, then we are no longer dealing with a "natural" system. It has now become a "managed" one. We must achieve a new level of equilibrium--a "management equilibrium." This is different from but can be equally as stable as the "natural equilibrium" that it replaces. The precise nature of this new state will stem from the choice of managed outputs framed within the physical and biological limitations of this piece of environment.

In shifting from natural equilibrium to a managed one, some species may be eliminated, some species may be replaced with other native or domestic species, plant communities may be simplified while still retaining enough diversity for stability, optimum combinations of goods and services may be yielded, food chains may be shortened, metabolic waste reduced, energy flow and nutrient cycling speeded up but in an

orderly way. The managed system is in a new dynamic equilibrium with the controlling forces (climate, geologic materials, and available organisms.). It reaches a new steady state.

Some man-made input is required to maintain the new equilibrium. As a rule of thumb, the greater the deviation of the managed state from the natural one, the more of man's effort is needed to maintain an equilibrium and the greater is the hazard of reaping unexpected consequences. Conversely, the more diversity that is retained, the easier and cheaper it is to achieve and maintain the new equilibrium. Once achieved, any slackening of man's effort will usually result in catastrophe to his interests while Nature sets about to restore still another level of stability.

6. Reversibility

The hazards of reversible management actions are minor in comparison to those of nonreversible actions. In view of the many biological unknowns with which management must deal, common sense suggests that nonreversible actions should be approached with a great deal of caution. Faulty reversible actions are less critical.

Our objective should be to minimize the unintended consequences of management actions. Mostly, we are dealing in trade-offs; that is, recognizing, to the extent practical, the "total" costs and benefits of a proposed course of action and of its alternatives. Each management proposal should be viewed in these terms before an action program is undertaken and the depth of detailed study preceeding the action should be proportional to the degree of nonreversibility involved.

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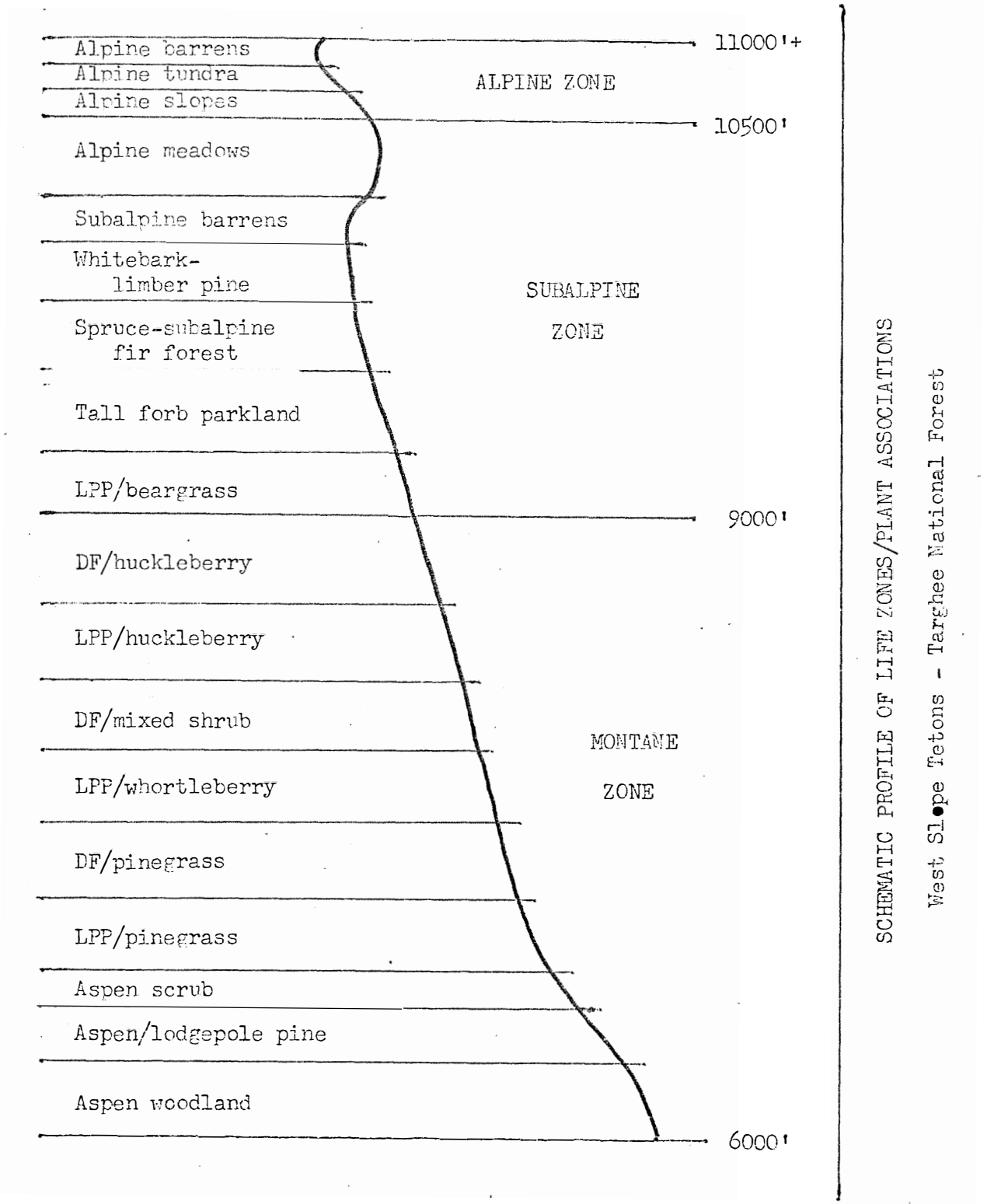
PART VI - APPENDIX DOCUMENTS

1. Schematic Profile of Life Zones/Plant Associations.
2. A Summary of Site Data from Lodgepole Pine Stands.
3. Supporting Climatic Data.
4. The Role of Fernleaf Ligusticum in Tall Forb Communities.
5. Successional Development of Douglas-fir onto Curlleaf Mountain - Mahogany Sites.
6. Study Site Location Map.
7. Study Site Field Notes (included in only a few of the copies).

Appendix 1


Alpine barrens
Alpine tundra
Alpine slopes
Alpine meadows
Subalpine barrens
Whitebark-
limber pine
Spruce-subalpine
fir forest
Tall forb parkland
LPP/beargrass
DF/huckleberry
LPP/huckleberry
DF/mixed shrub
LPP/whortleberry
DF/pinegrass
LPP/pinegrass
Aspen scrub
Aspen/lodgepole pine
Aspen woodland
ALPINE ZONE
SUBALPINE
ZONE
MONTANE
ZONE
11000'+
10500'
9000'
6000'
SCHEMATIC PROFILE OF LIFE ZONES/PLANT ASSOCIATIONS
West Slope Tetons - Targhee National Forest

Appendix 2

A SUMMARY OF SITE DATA FROM LODGEPOLE PINE STANDS

| Community Attribute | Site Number | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 9 | 10 | 11 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 33 | 34 | 42 | 43 | 45 | 46 |
| Overstory Crown Density | 60 | 68 | 55 | 65 | 0 | 55 | 50 | 60 | 70 | 75 | 60 | 85 | 0 | 65 | 65 | 68 | (17) | (13) | (30) | (22 |
| Age Dominant LPP | 1 | 83 | 103 | 92 | 1 | 119 | 80-85 | 90 | 82 | 82 | 28 | 90-95 | 1 | 83-85 | 58-64 | 62 | 1 | 1 | 1 | 1 |
| Herbaceous Yield | 1 | 1 | 1 | 1 | $60_0$ | $90_0$ | $110_0$ | $50_0$ | $50_0$ | $60_0$ | $30_0$ | $10_0$ | $9_{\bullet 0}$ | $100_0$ | $60_0$ | $60_0$ | $66_6$ | $66_8$ | $66_3$ | $38_8$ |
| Elevation (nearest 100 feet) | | 72 | 72 | 72 | 63 | 63 | 64 | 66 | 64 | 69 | 74 | 72 | 65 | 65 | 70 | 70 | 1 | 1 | 1 | 1 |
| LPP Reprod. most Successful | + | + | − | − | − | − | + | − | + | − | + | − | − | − | − | − | 1 | + | + | + |
| DF Reprod. most Successful | − | + | + | + | − | − | − | + | − | + | − | − | − | + | + | + | 1 | − | − | − |
| Mixed Species Reprod. most Successful | − | DF LPP | DF AF | − | − | − | − | DF AF | − | − | − | − | − | − | − | − | 1 | − | − | − |
| Reprod. very scarce or absent | − | − | − | − | + | + | − | − | − | − | − | + | + | − | − | − | 1 | − | − | − |
| Understory Dominant- CARUBE | + | − | − | − | − | + | + | + | + | + | − | − | + | + | − | − | + | + | + | + |
| Understory Dominant-tall VACCIN | − | − | − | + | − | − | − | − | − | − | + | + | − | − | + | + | − | + | − | − |
| Understory Dominant-low VACCIN | − | + | + | − | − | − | + | − | − | − | + | − | − | − | − | − | − | + | − | − |
| Understory Dominant- CAGEYE | − | − | − | − | + | − | − | − | − | − | + | − | − | − | − | − | − | − | − | − |
| Understory Subdominant- CARUBE | − | − | − | − | − | − | − | − | − | − | + | + | − | − | + | + | − | − | − | − |
| Understory Subdominant-tall VACCIN | + | − | + | − | − | − | − | − | − | − | − | − | − | + | − | − | − | − | + | − |
| Understory Subdominant-low VACCIN | − | − | − | − | − | − | − | − | − | + | − | + | − | − | − | − | − | − | − | + |
| Understory Subdominant-Mixed Shrub | − | − | − | − | − | − | − | − | − | − | + | + | − | − | + | − | − | + | − | − |
| Understory Subdominant-Mixed Forb | − | $XE_{TE}$ | $CAC_E$ | $XE_{TE}$ | + | + | + | + | + | − | + | $CAC_E$ | + | + | − | − | + | − | − | − |

APPENDIX 3

AVERAGE MONTLY AND ANNUAL MAXIMUM, MEAN, AND MINIMUM TEMPERATURES IN DEGREES FAHRENHEIT

FOR THE PERIOD 1931 to 1960

| STATION | | JAN. | FEB. | MAR. | APR. | MAY. | JUN. | JUL. | AUG. | SEP. | OCT. | NOV. | DEC. | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ASHTON 1S | Max. | 28.1 | 32.8 | 39.4 | 54.6 | 67.3 | 73.9 | 83.3 | 81.5 | 73.0 | 60.9 | 41.4 | 32.0 | 55.7 |
| (5220 ft.) | Mean | 18.1 | 21.7 | 27.9 | 21.4 | 51.7 | 57.6 | 64.5 | 62.5 | 54.8 | 45.4 | 30.3 | 22.1 | 41.5 |
| | Min. | 8.2 | 10.6 | 16.4 | 28.3 | 36.0 | 41.3 | 45.6 | 43.4 | 36.5 | 29.8 | 19.2 | 12.2 | 27.3 |
| DRIGGS | MAX. | 30.0 | 34.3 | 39.6 | 51.8 | 62.8 | 70.7 | 82.1 | 80.9 | 71.5 | 59.3 | 41.6 | 34.0 | 54.9 |
| (6097 ft.) | Mean | 17.3 | 21.1 | 27.1 | 38.6 | 47.9 | 55.0 | 63.7 | 62.1 | 53.7 | 43.6 | 29.0 | 21.9 | 40.1 |
| | Min. | 4.1 | 7.9 | 14.7 | 25.0 | 33.2 | 39.3 | 45.6 | 43.3 | 35.8 | 27.9 | 15.9 | 9.8 | 25.2 |
| TETONIA | Max. | 29.0 | 31.4 | 37.8 | 49.3 | 61.7 | 70.9 | 81.4 | 79.9 | 71.0 | 57.5 | 39.4 | 31.5 | 53.4 |
| | Mean | 15.2 | 19.7 | 26.6 | 39.4 | 48.5 | 54.4 | 63.0 | 61.2 | 53.3 | 43.2 | 28.8 | 20.9 | 39.5 |
| | Min. | 6.6 | 8.9 | 13.7 | 24.7 | 32.8 | 39.1 | 44.1 | 42.7 | 35.4 | 27.0 | 14.5 | 8.7 | 24.9 |
| ALTA INNW | Max. | 29.2 | 33.6 | 39.1 | 49.8 | 59.7 | 69.2 | 80.2 | 78.8 | 69.7 | 57.5 | 40.3 | 32.7 | 53.3 |
| (6411 ft.) | Mean | 18.4 | 21.8 | 27.2 | 37.8 | 47.5 | 54.4 | 63.1 | 61.3 | 53.3 | 43.6 | 29.1 | 22.6 | 40.0 |
| | Min. | 7.7 | 10.0 | 15.3 | 25.7 | 33.8 | 39.7 | 46.0 | 44.0 | 36.9 | 29.8 | 18.0 | 12.5 | 26.6 |

## PRECIPITATION DATA

### Date of First Snowfall of 1 Inch or More

| STATION | MEDIAN | EARLIEST |
|---|---|---|
| Ashton 1S | Nov. 8 | Sept. 26 |
| Island Park Dam | Oct. 17 | Aug. 23 |

### Date of Last Snowfall of 1 Inch or More

| STATION | MEDIAN | LATEST |
|---|---|---|
| Ashton 1S | Apr. 6 | May 22 |
| Island Park Dam | May 9 | Jun. 8 |

### Mean Snow Depth and Water Equivalent on April 1

| STATION | ELEV. | PERIOD | SNOW | WATER |
|---|---|---|---|---|
| Grassy Lake | 7,230' | 1940 to 1967 | 88 | 34.7 |
| Darby Canyon | 8,250' | 1961 to 1964 | 57 | 19.8 |
| State Line | 6,400' | 1936 to 1964 | 46 | 15.4 |
| Teton Pass | 8,500' | 1945 to 1967 | 97 | 35.3 |

## PRECIPITATION - MONTHLY AND ANNUAL MEANS - 1931 to 1960

| STATION | Jan. | Feb. | Mar. | Apr. | May. | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ashton 1S | 1.82 | 1.77 | 1.39 | 1.04 | 1.45 | 1.91 | .82 | .95 | .94 | 1.35 | 1.56 | 1.89 | 16.89 |
| Driggs | 1.41 | 1.40 | 1.17 | 1.10 | 1.74 | 2.05 | .86 | 1.22 | 1.11 | 1.29 | 1.05 | 1.39 | 15.79 |
| Tetonia | 1.12 | .93 | 1.10 | 1.00 | 1.79 | 1.49 | .70 | .88 | .87 | 1.03 | .83 | 1.10 | 12.84 |
| Alta 1NNW | 1.60 | 1.48 | .151 | 1.48 | 2.04 | 2.29 | .94 | 1.19 | 1.28 | 1.48 | 1.41 | 1.51 | 18.21 |

GROWING AND COOLING *DEGREE DAYS - 1931-1965

(Sum of weekly medians for bases of 40°, 50°, 60°, and 70°)

ASHTON 1S

| | | |
|---|---|---|
| 40° Base - | 2982 | between April 12 and October 31. |
| 50° Base - | 1263 | between April 26 and October 17. |
| 60° Base - | 236 | between June 7 and September 12. |
| 70° Base - | 4 | between July 12 and August 1. |

DRIGGS

| | | |
|---|---|---|
| 40° Base - | 2684 | between April 12 and November 7. |
| 50° Base - | 1134 | between May 3 and October 10. |
| 60° Base - | 232 | between June 21 and September 12. |
| 70° Base - | 7 | between July 5 and August 8. |

*Growing degree days are calculated by subtracting the base temperature from the mean daily temperature. If mean daily temperature is less than the base, the value in degree days is zero.

Growing degree days do not provide a direct measure of growing conditions since they are computed from the daily mean temperature rather than from the mean daytime temperature. However, there should be a relationship between the two values and the degree day values should be valid for comparison of relative growing conditions between stations. Viewed in this way, the two reported stations (an elevation difference of 877 feet) can be compared. Assuming that the 50° base approximates the lower end of the optimum range of temperature for photosynthetic activity, the degree day value is somewhat less at the higher elevation station. Also, the period during which degree days are accrued is about two weeks shorter at the higher elevation station, indicating a somewhat shorter growing season.

If this relationship is applied in a general way to the elevational gradients of the study area, it suggests a greater uniformity in the temperature component of growing conditions in the plateau area than in the mountain area. This assumed difference, coupled with the lesser topographic diversity, suggests a difference in behavior of historic wildfire and could result in differing after effects. This, in turn, could influence biological characteristics. Perhaps this is a partial explanation for the differences in reaction to interference and for the lesser biotic diversity in the plateau area.

Appendix 4

THE ROLE OF FERNLEAF LIGUSTICUM IN TALL FORB COMMUNITIES

Tall forb communities dominated by fernleaf ligusticum (Ligusticum filicinum are found in several places. Where observed, the sites are open areas at upper elevations, either in the lower subalpine zone or in the ecotone between this and the montane zone. They seem often to occupy sites underlain by limestone at relatively shallow depths and topographically oriented with the dip of the bedrock. They have usually been considered to be the result of overgrazing by sheep. I don't think this relationship is quite so clear as to warrant that assumption without further investigation.

The sites give me the impression of being more xeric than are the other tall forb sites in proximity to them. The species occuring in these communities are, for the most part, the same in both cases but the percentages in the composition are quite different.

Is this a result of improper grazing or might it be associated with a progressive downslope deepening of the soil mantle? The bedrock depth seems often to range from exposed or very shallow at the top to deep to very deep at the slope bottom. In this gradient, the fernleaf ligusticum community appears to occupy the upper intermediate position and may be a normal successional stage related to soil development.

Appendix 5

# SUCCESSIONAL DEVELOPMENT OF DOUGLAS-FIR ONTO CURLLEAF MOUNTAIN-MAHOGANY SITES

Observations in a number of areas have indicated that curlleaf mountain-mahogany (Cercocarpus ledifolius) may often be a xeric equivalent to Douglas-fir (Pseudotsuga menziesii) on sites derived from limestone parent materials. Mahogany on these sites does not appear to be fire induced nor to have been much influenced by domestic livestock grazing. Rather, those sites too well-drained or too low in soil-moisture holding capacity and too xeric to allow the establishment of Douglas-fir tend to be occupied by mahogany. It has not been clear whether this represented a successional stage of Douglas-fir community development or was an edaphic climax representation of its own. The phenomenom was investigated on several sites in Darby Canyon, Targhee National Forest.

In lower Darby Canyon and elsewhere in the general vicinity, mahogany stands occupy certain xeric south-exposure colluvial slopes associated with limestone/dolomite cliffs. The variety of expressions found in this area are used to illustrate the hypothesis of Douglas-fir succession into these stands. Evidence is presented to show a sequence of successional development from mahogany to Douglas-fir in this area. Origin of the mahogany stands themselves was not investigated.

At first, the sites are occupied by pure curlleaf mountain-mahogany with canopy density of about 40 percent. Herbaceous understory is

dominated by bearded bluebunch wheatgrass (Agropyron spicatum), a rrowleaf balsamroot (Balsamorhiza sagittata), oneflower helianthella (Helianthella uniflora), showy goldeneye (Viguiera multiflora), big sagebrush (Artemisia tridentata), creeping barberry (Berberis repens), wayside gromwell (Lithospermum ruderale), snowberry (Symchoricarpus spp.), Nuttall aster (Aster perelegans), and serviceberry (Amelanchier alnifolia) with several other species in lesser amounts. Herbaceous yield is 900-1000 pounds dry weight per acre. (This stage is represented by Sites WST-28 and -31).

Site conditions become sufficiently modified over time to permit the establishment of Douglas-fir reproduction within the mahogany stand. Initial Douglas-fir establishment was observed to occur on the upslope side of mature mahogany stems.

The invasion proceeds, in part, by a random scattering of Douglas-fir throughout the mahogany stand and, in part, by a downslope encroachment from existing Douglas-fir stands higher on the slopes. Apparently, increased water-holding capacity resulting from soil profile development is the principal factor in the success of Douglas-fir reproduction.

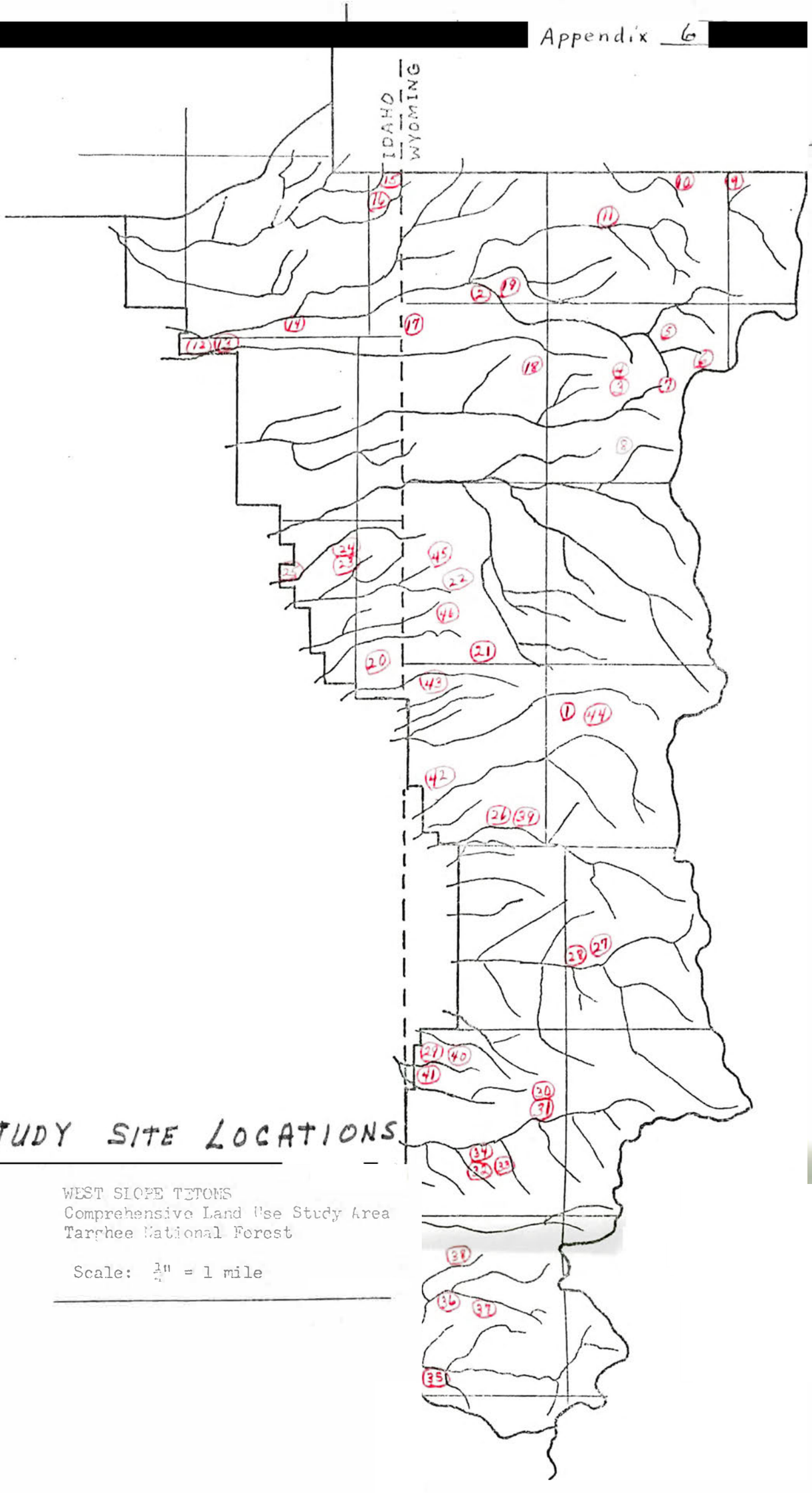
Establishment of Douglas-fir continues at a gradual but steady pace until the site is occupied by a vigorous mixed-age Douglas-fir stand with crown density of 35 percent or so. Mahogany persists as a sub-dominant at about its original density and herbaceous understory is much the same, both in kind and amount, as under the original mahogany stand. (Site WST-30 represents this stage).

It is not known how long this stage may last. Presumably, it is related to the longevity of the established mahogany plants since successful regeneration of the species ceases prior to this stage. The

age of Douglas-fir indicates that the successional sequence from an established mahogany stand to this stage takes place in about 200 years.

It is thought that the mahogany eventually dies out, leaving Douglas-fir in full control, although no sites were located that illustrate this last stage. Site modification by the Douglas-fir overstory then causes a gradual change in the understory, eventually resulting in a typical Douglas-fir/mixed shrub community with no obvious indication that the site was once occupied by curlleaf mountain-mahogany.

Appendix 6




# STUDY SITE LOCATIONS

WEST SLOPE TETONS
Comprehensive Land Use Study Area
Targhee National Forest

Scale: $\frac{1}{4}$" = 1 mile